PCT

WORLD INTELLECTUAL PROPERTY ORGANIZATION
International Bureau

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 5 : C02F 3/30, 1/78	A1	(11) International Publication Number: WO 94/07802 (43) International Publication Date: 14 April 1994 (14.04.94)

(21) International Application Number: PCT/AU93/00519

(22) International Filing Date: 7 October 1993 (07.10.93)

(30) Priority data:
PL 5162 7 October 1992 (07.10.92) AU

(71) Applicant *(for all designated States except US)*: ENVIRO-DESIGN TECHNOLOGY PTY. LTD [AU/AU]; 9 Gregory Street, North Richmond, NSW 2754 (AU).

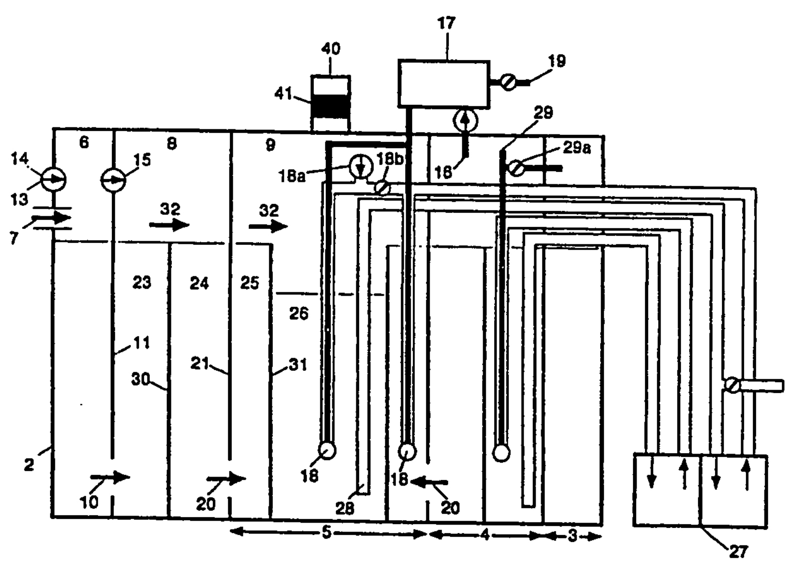
(72) Inventors; and
(75) Inventors/Applicants *(for US only)* : CORNISH, John, Gilbert, David [AU/AU]; CORNISH, James, David [AU/AU]; 9 Gregory Street, North Richmond, NSW 2754 (AU). BLACKMAN, Robert, James [AU/AU]; 1/110 Neilson Crescent, Bligh Park, NSW 2756 (AU).

(74) Agent: SHELSTON WATERS; 55 Clarence Street, Sydney, NSW 2000 (AU).

(81) Designated States: AT, AU, BB, BG, BR, BY, CA, CH, CZ, DE, DK, ES, FI, GB, HU, JP, KP, KR, KZ, LK, LU, LV, MG, MN, MW, NL, NO, NZ, PL, PT, RO, RU, SD, SE, SK, UA, US, UZ, VN, European patent (AT, BE, CH, DE, DK, ES, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, ML, MR, NE, SN, TD, TG).

Published
With international search report.

(54) Title: ODOUR CONTROLLED WASTE WATER TREATMENT SYSTEM



(57) Abstract

The present invention provides an odour controlled waste water treatment system for sewage, domestic effluent and the like. The system (1) comprises a tank (2) having at least three processing chambers including a first chamber (3) for an aerobic treatment of the waste including therein a first head space (6) and an inlet (7) to receive the untreated waste, a second chamber (4) for aerobic treatment of the product from the first chamber (3) and including therein a second head space (8), a third chamber (5) for sterilisation of the product of the second chamber and including therein a third head space (9), means to prevent back flow of liquid and gas from said second chamber to said first chamber, means (15) to admit air into said second head space, means (17 and 18) to extract air from said second head space to generate and deliver ozone to the waste product in said third chamber, and means (40) to extract substantially deodorised gas from said third head space.

FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AT	Austria	FR	France	MR	Mauritania
AU	Australia	GA	Gabon	MW	Malawi
BB	Barbados	GB	United Kingdom	NE	Niger
BE	Belgium	GN	Guinea	NL	Netherlands
BF	Burkina Faso	GR	Greece	NO	Norway
BG	Bulgaria	HU	Hungary	NZ	New Zealand
BJ	Benin	IE	Ireland	PL	Poland
BR	Brazil	IT	Italy	PT	Portugal
BY	Belarus	JP	Japan	RO	Romania
CA	Canada	KP	Democratic People's Republic of Korea	RU	Russian Federation
CF	Central African Republic	KR	Republic of Korea	SD	Sudan
CG	Congo	KZ	Kazakhstan	SE	Sweden
CH	Switzerland	LI	Liechtenstein	SI	Slovenia
CI	Côte d'Ivoire	LK	Sri Lanka	SK	Slovak Republic
CM	Cameroon	LU	Luxembourg	SN	Senegal
CN	China	LV	Latvia	TD	Chad
CS	Czechoslovakia	MC	Monaco	TG	Togo
CZ	Czech Republic	MG	Madagascar	UA	Ukraine
DE	Germany	ML	Mali	US	United States of America
DK	Denmark	MN	Mongolia	UZ	Uzbekistan
ES	Spain			VN	Viet Nam
FI	Finland				

Title: "ODOUR CONTROLLED WASTE WATER TREATMENT SYSTEM"

TECHNICAL FIELD

The present invention relates to waste water treatment systems, where waste water will hereinafter be taken to include within its meaning water combined with solid waste or particulate matter such as in the form of a slurry.

BACKGROUND ART

The invention has been developed primarily for use in the treatment of sewage and domestic effluent and will be described hereinafter with reference to this application. However, it will be appreciated that the invention is not limited to this particular field of use and is also suitable for treating industrial waste, storm water and effluent from farm animal enclosures, hotels and the like.

Current common domestic waste treatment comes in three forms: sewerage, septic or bio-organic. Sewerage is installed at domestic locations and connected to government controlled sewerage treatment and disposal systems which handle all water and waste outflow. Septic systems are connected to individual domestic structures where sewerage is not available, and are generally designed to handle single house units. These systems need to be pumped out on a regular basis and provide no form of recycling. Bio-organic systems are similar to septic systems except that the waste is treated organically and chemically and the resultant product may be used to irrigate an area of approved dimensions in a prescribed manner.

The bio-organic systems are highly desirable in that they require less maintenance than septic systems and permit a degree of recycling of the waste. Whilst a number of bio-organic systems are currently available, these systems suffer from several inherent disadvantages.

A first of these disadvantages is that although pump-out frequency is reduced over septic systems, this still needs to be done regularly due to the build up of sludge that accumulates with use.

Another major disadvantage relates to the fact that the prior art systems do not contain any effective odour control mechanisms. This places a limitation on the proximity with which the units can be placed relative to

dwellings and the like, making the option of using such systems undesirable or even unacceptable in some situations.

Also of considerable importance is the size and corresponding efficiency of the currently available systems which inhibits their use in many applications.

Another disadvantage is that the majority of these bio-organic systems use chlorine as the final disinfectant. The chlorine product used contains a number of heavy metals and other products as stabilizing agents. Also, not all of the free chlorine is used in the sterilisation process. The end result is an output that has a high concentration of chemicals and compounds that are not environmentally friendly.

It is an object of the present invention to provide a waste water treatment system that overcomes or at least ameliorates one or more of the above discussed disadvantages of the prior art.

DISCLOSURE OF THE INVENTION

According to a first aspect of the invention there is provided an odour controlled waste water treatment system comprising,

a tank having at least three processing chambers including,

a first chamber for anaerobic treatment of the waste including therein a first head space and an inlet to receive said untreated waste,

a second chamber for aerobic treatment of the product from the first chamber and including therein a second head space,

a third chamber for sterilisation of the product of the second chamber and including therein a third head space,

means to prevent back flow of liquid and gas from said second chamber to said first chamber,

means to admit air into said second head space,

means to extract air from said second head space to generate and deliver ozone to the waste product in said third chamber, and

means to extract substantially deodorised gas from said third head space.

Preferably, back flow of liquid and gas from the second chamber to the first chamber is prevented by interconnecting these chambers by a submerged transfer passage and ensuring the pressure in the second head space is maintained at a level equal to or less than the pressure in the first head space.

In one embodiment, this is achieved by admission of air via a first one-way valve to the first head space and selectively permitting egress of air from that first head space into the second head space via an intermediate second one-way valve. In this way extraction of air from the second chamber for use in the ozone generation, reduces the pressure in the second

head space, causing the second one-way valve to open and admit air from the first chamber. This one-way flow similarly causes a reduction in pressure in the first head space which causes additional replenishing air to be drawn into the first head space via the first one-way valve.

It is further preferred that means are provided to deliver air to the waste product in the second chamber for aerobic treatment thereof, desirably said treatment air also being extracted at least in part from the second head space and/or the first headspace.

In a preferred form the second chamber also includes separating baffle means to divide the second chamber into two separate first and second liquid/slurry sub-chambers to permit partial clarification of the waste by settlement, the second of said sub-chambers preferably including a bacteriological gravel filter.

Desirably, the second and third chambers are also interconnected by means of a submerged transfer passage.

It is preferred that the third chamber also includes separating baffle means to divide the third chamber into two separate third and fourth liquid/slurry sub-chambers to permit further clarification of the waste by settlement prior to extraction from the system. Preferably ozone is delivered to both sub-chambers of the third chamber.

Desirably, waste water flow between the pairs of

liquid sub-chambers defined above is over, or through an upper portion of, each of said separating baffle means.

Preferably, the deodorised gas extraction means also includes additional filtration means.

Desirably, the treated waste is extracted from the fourth sub-chamber by means of a pump, air preferably being admitted to the third head space during pump out by bi-directional flow through the gas extraction means.

According to a second aspect of the invention there is provided a waste water treatment system defining a waste water flow path therethrough, the system including a plurality of baffles spaced along all or a portion of said flow path to define a plurality of discrete chambers or sub-chambers, said chambers being serially inter-connected by transfer ducts generally alternately located adjacent a lower portion and then an upper portion of each chamber so as to create a substantially sinusoidal flow of waste water through said discrete chambers along said portion of the flow path.

Desirably, the baffle spacing and waste water flow rate are selected to ensure sufficient turbulence along said portion of the path to inhibit excessive deposition of sludge and substantially avoid stratification of bacteria type within the waste water travelling therethrough.

Desirably, the first chamber of the preferred embodiment of the first aspect of the invention is

divided in accordance with the second aspect by means of spaced apart baffles into a plurality of serially interconnected sub-chambers wherein, more preferably, flow of said waste through said sub-chambers is substantially sinusoidal, passing over or through an upper portion of a first baffle and under or through a lower portion of the next baffle in a repetitive manner, prior to passing into the second chamber. It is further desired that the flow through the remaining chambers and sub-chambers is also substantially sinusoidal.

In a preferred embodiment the first, second and third chambers are vertically co-extensive and substantially co-axial, the first chamber being substantially annular and surrounding the second chamber which is similarly substantially annular and surrounding the substantially cylindrical third chamber. In this manner the flow is preferably circumferentially sinusoidal in the first chamber and desirably also radially sinusoidal between the subsequent chambers and sub-chambers.

BRIEF DESCRIPTION OF THE DRAWINGS

Two preferred embodiments of the invention will now be described, by way of example only, with reference to the accompanying drawings in which:

Figure 1 is a schematic sectional side view of a first preferred embodiment of the treatment system according to the invention, sectioned in a manner that

illustrates the flow paths intermediate the chambers and sub-chambers.

Figure 2 is a schematic sectional plan view of the treatment system shown in Figure 1, similarly sectioned to illustrate the liquid flow paths intermediate the chambers and sub-chambers;

Figure 3 is a schematic sectional side view of the first chamber shown in the previous two Figures, illustrating the flow path therethrough in accordance with the second aspect of the invention;

Figure 4 is a schematic sectional part side view of the treatment system shown in Figures 1 and 2 illustrating the air/gas flow through the processing chambers;

Figure 5 is a schematic plan view of the system further illustrating the air/gas flow through processing chambers 3 and 4;

Figure 6 is a schematic sectional side view of a second embodiment treatment system according to the invention specifically adapted for treating storm water or rivers and the like.

Figure 7 is a schematic plan view of the inlet of the system shown in Figure 6; and

Figure 8 is a schematic end view of the inlet of the system shown in Figure 6.

BEST MODE FOR CARRYING OUT THE INVENTION

Referring first to Figures 1 to 5, the system 1

includes a tank 2 having three general processing chambers 3, 4 and 5 that are, in the preferred form illustrated, vertically co-extensive and substantially co-axial to define a series of nested annular chambers around a cylindrical core chamber.

The first outer annular chamber 3 includes a first head space 6 and an inlet 7 to receive the untreated waste. The second chamber 4 similarly includes a second head space 8 and the third chamber 5 a corresponding third head space 9.

The first and second chambers are interconnected for liquid/slurry transfer therebetween by means of a submerged transfer duct 10 provided in a lower portion of a cylindrical partition 11 that separates the two chambers. In Figures 1 and 2 the lower transfer ducts are indicated by shaded arrows and the upper transfer ducts by solid arrows.

Also connected to the first chamber is an air inlet 13, the air inlet preferably including a first one-way valve 14 to prevent backflow of air through the inlet. Means to admit air to the second head space 8 is provided in the form of second one-way valve 15. This valve 15 is disposed in an upper portion of the partition 11 separating the first and second chambers and permits air flow from the first head space 6 to the second head space 8.

Connected to the second head space 8 by means of a

one-way intake 16, is an ozone generator 17, which includes means to deliver ozone to the waste in third chamber 5 in the form of two ozone diffusers 18. The diffusers may comprise a series of micro-venturis which minimise the size of the ozone bubbles thereby maximising the surface area available for sterilisation.

In the preferred form, the duct connecting the two diffusers includes a one-way valve 18a to admit air to the duct to prevent syphoning of incompletely treated waste from sub-chamber 25 to final sub-chamber 26. A gate valve 18b is also provided in that duct such that delivery of ozone to final sub-chamber 26 is optional.

The second and third chambers 4 and 5 are also interconnected for liquid/slurry transfer therebetween by means of one or more submerged passages 20 provided in a lower portion of a cylindrical partition 21 that separates the two chambers.

The second and third chambers are each in this preferred embodiment divided into two distinct liquid/slurry sub-chambers. The second chamber 4 includes a first annular sub-chamber 23 adjacent the first chamber 3 for aerobic treatment of the waste and a subsequent second annular sub-chamber 24 for treatment and clarification of the waste by bacteriological gravel filtration.

Similarly, the third chamber 5 includes a third annular sub-chamber 25 adjacent the second sub-chamber

24 for clarification and/or sterilisation of the waste by settlement and/or ozone treatment and a fourth generally cylindrical sub-chamber 26 which may also include sterilisation by ozone treatment from which the final treated product is removed. Removal of the treated effluent is effected by means of a pump 27 connected to an extraction pipe 28.

The same extraction pump 27 is also used to deliver dissolved air to the first sub-chamber 23 for aerobic treatment of the waste therein. The pump 27 operates a vacuum venturi which causes air to be drawn in from the second head space 8 and/or the first head space 6 by means of an inlet arrangement 29 and delivered to the waste in sub-chamber 23 in micro bubbles formed via micro venturis (not shown).. The inlet 29 includes a gate valve 29a to optionally block entrainment of air from the first headspace 6. These micro bubbles also assist in separating the suspended solids by selective floatation of the small particles, a technique known as dissolved air flotation. The operation of this technique will be discussed in more detail at a later stage.

The second and third chambers are preferably divided by respective cylindrical partition walls 30 and 31, waste flowing through transfer ducts 32 provided in an upper portion of or over walls 30 and 31 to transfer waste between adjacent sub-chambers.

The first annular chamber 3 is circumferentially divided by means of radially extending baffles 35 into a plurality of serially interconnected sub-chambers 36 as shown schematically in Figures 2 and 3. The baffles are alternatively provided with transfer ducts 38 in an upper portion and transfer ducts 37 in a lower portion. Vent passages 39 are also provided in the upper portion of those alternate baffles having lower transfer ducts 37. The direction of waste flow in this first chamber is thereby substantially sinusoidal in a circumferential direction. The direction of air/gas flow through chamber 3 is best shown in Figure 5 where double arrows indicate two-way flow and single arrows indicate the provision of one-way valves.

The preferred embodiment has been modelled to achieve a flow rate compatible with allocating approximately 36% of the total treatment time to the anaerobic treatment process in chamber 3. The terminal baffle contains an upper transfer duct to ensure that the second aerobic treatment chamber 4 is filled under the influence of gravity through the lower transfer ducts 10 in a similar manner to a plumbing "U"-bend. This lower transfer duct system maintains the gaseous separation of chamber 3 from chamber 4 contributing to the operation of the odour elimination cycle described later in more detail. Furthermore, the subsequent transfer through the upper duct formed by the gap above

wall 30 followed by transfer through the lower duct 20 in wall 21, then over dividing wall 31, results in a flow pattern in chambers 4 and 5 that is substantially sinusoidal in a generally radially inward direction.

Turning finally to the centre chamber, an air outlet 40 is also connected with head space 9 that includes, in the preferred form shown, an in-line carbon filter unit 41.

In use, sewage is directed via the inlet 7 into the first sub-chamber 36' of the processing chamber 3. Once this chamber is filled, the waste pours through a lower transfer duct 37 in the first baffle 35 and into the adjacent sub-chamber 36. Once more, as that sub-chamber fills, waste is passed through the upper transfer duct 38 provided in the subsequent baffle 35. In another embodiment the waste may be transferred from the first sub-chamber 36' by first passing through an upper transfer duct rather than a lower duct.

In this manner the sub-chambers 36 are progressively filled in an anti-clockwise direction as shown in Figure 2. The resulting sinusoidal flow through respective lower and upper transfer ducts provided in adjacent baffles results in sufficient turbulence to avoid stratification of the bacteria types, assists breakdown of solids by agitation and yet permits controlled progressive settlement of the contents. The system also provides sufficient residence

time for effective anaerobic digestion to occur by the various mechanisms well-known to those skilled in the art.

The sinusoidal flow arrangement ensures that all the waste must traverse the full depth of its current sub-chamber before proceeding to the next, to assure a uniform waste quality at the beginning of each subsequent treatment stage. The upper transfer ducts 38 act to clarify the waste by settlement of the solids, the size of particles transferred to the next sub-chamber being dependent on the current flow rate of the system. Larger particles are thereby retained in a sub-chamber for further breakdown such that the residence time is varied according to need. The lower transfer ducts 37 promote even sludge deposition and hence expose a greater surface area upon which bacteria can act.

It should be noted that the embodiment illustrated is designed for the southern hemisphere and promotes anti-clockwise flow which is assisted by the coriolis effect. Alternate embodiments adapted for use in the northern hemisphere desirably promote rotation in a clockwise direction for the same reason.

When the waste reaches the final sub-chamber 36 adjacent the inlet, the waste transfers into the first sub-chamber 23 via the submerged passages 10 provided in the cylindrical partition 11 that separates the two main

chambers. A sludge return facility (not shown) is also provided that periodically returns sludge accumulations in the final sub-chamber 36 to the adjacent inlet chamber for re-digestion.

The sub-chamber 23 is filled under gravity in a similar manner to a U-tube or plumbing U-bend. The pressure in the first and second head spaces is equalised by entraining air from the first head space 6 through the second one-way valve 15 to the second head space 8 as air is withdrawn from the second head space to aerate sub-chamber 23 and ozone generator 17. This passage of air from the first head space to the second head space similarly causes reduced pressure in the first head space causing entrainment of additional fresh air through the one-way valve 14 of the air inlet 13.

The waste product continues to fill the sub-chamber 23 until it reaches a level whereby waste flows through upper transfer ducts 32 provided in the annular partition wall 30 and into the second sub-chamber 24. In this manner there is partial settlement of the waste in sub-chamber 23 with predominantly liquid waste passing through the upper transfer ducts 32 into sub-chamber 24.

Sub-chamber 24 includes a bacteriological gravel filter which in a preferred form consists of "pebbles" which are largest at the bottom of the chamber and decrease in size towards the top of the chamber, the

waste coating the pebbles as the chamber fills. In other embodiments the filter may comprise pebbles of the same size or varying size that are randomly mixed. Detailed operation of this filter is discussed at a later stage.

As sub-chamber 24 fills waste simultaneously begins to fill sub-chamber 25 by passing through the lower passages 20 provided in a lower portion of a partition wall 21 separating the two adjacent chambers.

In the embodiment illustrated, ozone is admitted to the waste in sub-chambers 25 and 26 of chamber 5 by means of the ozone diffuser 18 comprising micro-venturis connected with the ozone generator 17.

The air intake 16 to the ozone generator 17 extracts air from the second head space 8, thereby simultaneously deodorising the air and gas which is passed back into the waste in the form of ozone. Additional air can also be provided to the ozone generator from an external source 19 if required. The cylindrical partition wall 21 separating sub-chambers 24 and 25, prevents ozone in sub-chamber 25 from contaminating the waste undergoing aerobic treatment in chambers 23 and 24 and thereby destroying the bacteria important to those aerobic digestion processes.

It should be noted that the lower submerged passages 10 and 20 are disposed a spaced distance from the base of the tank 2 to allow partial settlement of

particulate matter before waste is transferred between chambers and to ensure that the passages do not become blocked by sludge build up.

Finally, as sub-chambers 24 and 25 fill, further settlement occurs in chamber 25, with the fully treated waste then passing over partition wall 31 and into the final central cylindrical sub-chamber 26. The waste is then ozone treated again to ensure a residual ozone level in the final product at that time, to prevent viral or bacterial contamination of the water before it is pumped out.

The treated waste is then withdrawn via pump 27 through extraction pipe 28 for subsequent use in irrigation processes and the like, the short half-life of ozone ensuring that any residual ozone in the final effluent decomposes to simple molecular oxygen on use. As the treated waste is withdrawn, pressure equalisation in the third chamber 5 is facilitated in one embodiment by the bi-directional gas flow capabilities of the vent system 40/41 which permits air to enter the third head space 9.

This final sub-chamber 26 is provided with upper and lower water level sensors, the pump being actuated automatically once the higher level is reached and shutting off when the fluid level drops to the lower level.

Finally, residual air or gas present in the third

head space 9 as a result of the ozone treatment within that chamber passes out through air outlet 40 through the in-line carbon filter unit 41. The filter acts as a final cleaning stage for the air which will have been in any event substantially purified and deodorised by being passed through the ozone generator 17.

Operation of the anaerobic sinusoidal flow system, the aerobic treatment using the dissolved air floatation system and the bacteriological gravel filtration system will now each be discussed in more detail, commencing with the sinusoidal flow arrangement.

Generally, for domestic type waste, a minimum of two days anaerobic treatment is required to achieve adequate digestion. However, it will be appreciated that total residence times and volumes etc will vary according to the application.

It appears the optimal flow rate for chamber 3 of the tested domestic prototype unit requires a change over of inter-baffle contents 2 to 3 times in a 24 hour period. This is to maintain an adequate level of turbulence which is necessary for the reasons previously stated. Calculations for these flow rates were based on an average daily waste input of approximately 450 litres every 24 hour period from a household of 5 people. It follows that to achieve a flow rate within the required range the inter-baffle volume must be between 150 and 225 litres.

Modelling of these baffle spacing requirements on a domestic scale prototype version of the system (based on a household of 5 people) which would have an approximate volume of 3,800 litres, remembering that the anaerobic process encompasses 36% of the total treatment time, means that a total number of 9 baffles would result in an inter-baffle volume of approximately 160 litres and a mean circumferential inter-baffle spacing of approximately 0.63 metres. This would result in a turnover of the inter-baffle contents approximately 2.8 to 3 times in a 24 hour period.

This number of baffles has been chosen (i.e. 9 as opposed to 7) to set the inter-baffle volume at the lower end of the appropriate range and consequently elevate the rate of inter-baffle turnover to provide an adequate environment for the anaerobic treatment process.

Turning next to the aerobic treatment stage, the waste water treatment system of the preferred embodiment preferably utilises the dissolved air floatation system previously described in three of its five treatment chambers i.e. in the aerobic chamber 23 and the two ozonation chambers 25 and 26.

The air is dissolved into the waste water via the venturis so as to form micro air bubbles. These air bubbles attach to suspended solids in the water with which they come into contact. The number of air bubbles which attach to a particle depends on the surface area

of the particle, therefore, relative to mass, more bubbles attach to smaller particles - this is because smaller particles have a higher surface area to mass ratio than do larger particles.

When a sufficient number of air bubbles have attached to a particle it floats to the surface of the water. This dissolved air flotation system results in a layer of "foam" forming on the surface of the treated water. This foam contains all the suspended solids which have been extracted from the waste water in a convenient form for subsequent breakdown.

The preferred embodiment also utilises an intermittent aeration cycle to optimise the biological removal of phosphorus, ammonia and nitrates from the waste by providing periods of vigorous aeration followed by relative periods of anoxia.

Finally, we consider in more detail the bacteriological gravel filter system preferably used in sub-chamber 24.

Breakdown by certain bacteria types is inhibited by their inability to "trap" particles suspended in solution. Solids suspended in the contents of the aerobic chamber are taken out of solution by the dissolved air flotation system previously discussed. The foam which forms as a result of that system is then transferred to lie over the entrance to the gravel filter in sub-chamber 24. As the foam over the gravel

filter dissipates, the solid particles are allowed to fall back onto solution. The gravel filter then provides an optimal environment for waste breakdown by bacteria which require a surface against which they can trap and breakdown suspended particles.

To this end bacterial colonies become established, coating the surface of the pebbles, creating a "bio-slime". Particles suspended in solution collide with the surface of the pebbles becoming entrapped. In this environment the particles are exposed to concentrated bacterial digestion resulting in their breakdown.

The bacteriological gravel filter of the household sized unit provides a surface area equivalent to approximately 5 acres providing an ideal environment for bacterial growth and entrapment. In addition the gravel filter also traps larger waste particles via the mechanism of a conventional filter system. It is unlikely that larger waste will manage to access this level of the system due to the sinusoidal flow system and the efficiency of the anaerobic and aerobic steps performed in chambers 3 and 23. However, if present, these larger particles are then subjected to prolonged bacterial exposure in the filter resulting in their breakdown.

The preferred first embodiment described utilises a single pump to operate the aeration and ozone injection

systems and pump out the treated effluent making the overall design very cost efficient. Whilst it would be possible to have the same pump returning any sludge accumulation for re-digestion, the use of a small submersible pump for this purpose is preferred.

The final treated product has a purity level that approaches that achieved by conventional tertiary processing and is well suited for irrigation purposes and it may also be possible to use the treated water for other household applications.

An advantage of using ozone, other than enabling simultaneous deodorising of the system and being able to produce the sterilising agent in situ, is that unlike chlorine, the end product contains no residual heavy metals or other contaminants that may have been added as stabilisers.

The effectiveness of the system is assisted, with regards to treatment of the liquid, by the substantially sinusoidal flow paths within the system. The resulting flow characteristics allow agitation to break down solids, repeated settlement to assist clarification of the waste and ensure adequate residence time for the various biological processes to occur. Furthermore, ozone is a very powerful sterilising agent that is very effective in disinfecting the waste.

In terms of the air and gas flow through the system, it can be seen that air is discharged or vented

at one point only, having been entrained through the various processing stages including the ozone treatment, where it is substantially deodorised by the oxidation process that occurs therein.

The preferred embodiment described is positively vented. More specifically air is induced into the system by negative pressure created by withdrawing air to feed the dissolved air injection system and ozone generator 17. The air is ultimately expelled under positive pressure after the final treatment stage by the passage of air and ozone through the treatment chambers causing the used deodorised air to vent through the final air outlet 40.

A number of tests have been conducted on a prototype unit made in accordance with the preferred embodiment described that is treating domestic and industrial waste, the latest preliminary results of which are listed below.

TEST 1

PARAMETER	RAW INFLUENT (07/09/93)	FINAL PRODUCT (14/09/93)
Ammonia (as N) [mg/l]	22	0.4
B.O.D. (5)	250	6
Phosphorous (total) [mg/l]	12	8.6
Suspended Solids [mg/l]	180	8
Total Kjeldahl Nitrogen [mg/l]	30	2

By way of comparison, samples taken from a conventional bio-organic system operating under optimal conditions and analysed by the same laboratories revealed Total Nitrogen of 10, Ammonia of 1.3 and Suspended Solids between 12 and 21. These results are significantly higher than those of the system according to the invention and directly reflect the superior aspects of the design and operation of the present system.

Furthermore, the results tabulated above fall well within the limits set by the NSW Health Department for an aerated septic tank system i.e. 20 BOD, 30 Suspended Solids.

In addition these latest results (with the exception of phosphorus) also meet the published licensing requirements, set by the Environmental Protection Authority, for the Quaker's Hill Tertiary Treatment Plant - this plant is acknowledged as having one of the more strict licenses due to the plants efficiency. The license states that:

- Suspended solids must be below 10 for 50% of the time and below 15 for 90% of the time.
- BOD must be below 10 for 50% of the time and below 15 for 90% of the time.
- Phosphorus must be below 1.5 for 50% of the time and below 3 for 90% of the time.

- Ammonia must be below 1 for 50% of the time and below 2 for 90% of the time.
- Total Nitrogen must be below 10 for 50% of the time and below 15 for 90% of the time.

It is believed that the poor results obtained at this stage with regard to phosphorus are due partly to the high phosphorus content of the industrial influent component as compared to domestic waste. Improved results are being obtained, the general trend indicating that it will be possible to meet or exceed the licensing requirements above once operation of the system has been optimised.

In other embodiments made in accordance with the first aspect of the invention, the number of fluid treatment sub-chambers varies according to the application. Similarly, ozone addition to the waste in sub-chamber 26 is merely optional.

Referring next to Figures 6 to 8 there is shown an alternative embodiment made substantially in accordance with the second aspect of the invention that has been proposed for the treatment of river water and storm water and the like. Where possible, like reference numerals have been used to denote corresponding features.

This simplified system uses the sinusoidal flow arrangement of the second aspect, as also illustrated in Figure 3, to remove particulate solids, in combination

with one or more ozone sterilisation stages. A mesh screen 50 is also preferably provided at the inlet in accordance with the usual practice as a filter to prevent flotsam entering the system. The inlet also desirably includes catchment bins 51 for collecting the debris diverted by the screen 50.

The system also may include one or more gravel filtration stages such as shown at 52 depending on the degree of bacteriological digestion needed. Where the flow rates through the system are high, it may be preferable to put the gravel in chambers that have a lower in-feed duct (as shown) so that gravel is not washed through to the next chamber.

In the embodiment illustrated, the water enters the inlet 7, the flotsam being diverted to catchment bins 51 by the screen 50. The water then passes through a series of interconnected chambers in a substantially sinusoidal manner as illustrated. Passage through the chamber in this manner will help clarify the waste and prevent stratification of bacteria type for effective subsequent treatment with ozone on discharge from the system and, optionally, at a point within the system as shown.

At the first ozonation stage water from the adjacent down stream chamber is pumped to the previous chamber to induce the ozone via the preferred micro-venturi diffusers 18. The final treated effluent

is extracted via the pump 27 and ozonated on discharge. Where flow rates exceed the pump capacity, a one-way valve 53 permits discharge of the excess from the system.

Another advantage of the system is that by using an integral ozone generator in both embodiments as a primary sterilisation process, it will require much less power to operate than many of the prior art systems, particularly if the ozone generator is solar powered.

Another major advantage is that the effectiveness of the process means that the system will require less maintenance. It is anticipated that the first embodiment system according to the invention will require pumping out of residue much less often than was previously the case and may even be as infrequent as once every 7-10 years. Furthermore, there is no substantial floating scum build-up that requires removal as with the prior art systems as the majority of scum created is fully digested in the bacteriological gravel filtration stage.

Whilst the invention has been described with reference to specific examples, it will be appreciated by those skilled in the art that the invention may be embodied in many other forms.

CLAIMS

1. An odour controlled waste water treatment system comprising,

a tank having at least three processing chambers including,

a first chamber for anaerobic treatment of the waste including therein a first head space and an inlet to receive said untreated waste,

a second chamber for aerobic treatment of the product from the first chamber and including therein a second head space,

a third chamber for sterilisation of the product of the second chamber and including therein a third head space,

means to prevent back flow of liquid and gas from said second chamber to said first chamber,

means to admit air into said second head space,

means to extract air from said second head space to generate and deliver ozone to the waste product in said third chamber, and

means to extract substantially deodorised gas from said third head space.

2. A system according to claim 1 wherein back flow of liquid and gas from the second chamber to the first chamber is prevented by interconnecting these chambers by a submerged liquid transfer passage and ensuring that the gaseous pressure in the second head space is

maintained at a level equal to or less than the pressure in the first head space.

3. A system according to claim 2 wherein the first head space includes a one-way valve for admitting external atmospheric air thereto, a second one-way valve being provided intermediate the first and second head space such that extraction of air from the second head space for use in the ozone generation reduces the pressure in the second head space causing the second one-way valve to open and admit air from the first chamber which in turn causes a reduction in pressure in the first head space which causes additional replenishing air to be drawn into the first head space via the first one-way valve.

4. A system according to any one of the preceding claims including means to deliver air to the waste water in the second chamber for aerobic treatment thereof.

5. A system according to claim 4 wherein at least a part of said treatment air is extracted from the second head space and/or the first headspace.

6. A system according to claim 4 or claim 5 wherein the air is delivered to the waste in the form of micro bubbles by means of micro venturis.

7. A system according to any one of the preceding claims wherein the air is admitted to the second chamber intermittently to promote periods of vigorous aeration followed by periods of relative anoxia.

8. A system according to any of the preceding claims wherein the second chamber includes separating baffle means to divide the second chamber into two separate first and second liquid/slurry sub-chambers to permit partial clarification of the waste by settlement.

9. A system according to any one of the preceding claims wherein said second chamber or at least one of said sub-chambers in said second chamber includes a bacteriological gravel filter.

10. A system according to any one of the preceding claims wherein the second and third chambers are interconnected by means of at least one submerged transfer passage.

11. A system according to any one of the preceding claims wherein the third chamber includes separating baffle means to divide the third chamber into two separate third and fourth liquid/slurry sub-chambers to permit further clarification of the waste by settlement.

12. A system according to claim 11 wherein ozone is delivered to both the third and fourth sub-chambers of the third chamber.

13. A system according to any one of claims 8 or 9 and 11 or 12 wherein the waste water flow between the respective pairs of liquid sub-chambers is over, or through an upper portion of, the respective separating baffle means.

14. A system according to any one of the preceding

claims wherein the deodorised gas extraction means also includes additional filtration means.

15. A system according to any one of the preceding claims wherein the treated waste water is extracted from the final treatment chamber of the third chamber by means of a pump.

16. A system according to claim 15 wherein the treated liquid extraction pump is designed to also induce air to be used in the aeration and ozonation processes.

17. A system according to claim 15 or 16 wherein air is admitted to the third head space during pump out by bi-directional flow through the gas extraction means.

18. A system according to any one of the preceding claims wherein the first chamber is divided by means of spaced apart baffles into a plurality of serially interconnected sub-chambers wherein flow of waste water through said sub-chambers is substantially sinusoidal, passing over or through an upper portion of a first baffle and under or through a lower portion of the next adjacent baffle in a repetitive manner.

19. A system according to claim 18 wherein the baffle spacing and waste water flow rate are selected to ensure sufficient turbulence along said portion of the path to inhibit excessive deposition of sludge and substantially avoid stratification of bacteria type within the waste water travelling therethrough.

20. A system according to claim 18 or claim 19 wherein

the flow rate through the first chamber is designed to achieve a change over of sub-chamber contents of two to three times in a twenty-four hour period.

21. A system according to any one of the preceding claims wherein the residence time in the first anaerobic chamber is designed to be approximately 36% of the total treatment time.

22. A system according to any one of the preceding claims wherein waste flow between said first chamber and subsequent chambers and sub-chambers also defines a generally sinusoidal flow path.

23. A system according to any one of the preceding claims wherein the first, second and third chambers are vertically co-extensive and substantially co-axial.

24. A system according to claim 23 wherein the direction of flow through the first chamber is designed to be anti-clockwise for use in the Southern hemisphere and clockwise for use in the Northern hemisphere.

25. A system according to any one of the preceding claims wherein means are provided to return sludge accumulation in the first chamber adjacent the entry to the second chamber to the adjacent entry of the first chamber for re-processing.

26. A waste water treatment system defining a waste water flow path therethrough, the system including a plurality of baffles spaced along all or a portion of said flow path to define a plurality of discrete

chambers or sub-chambers, said chambers being serially interconnected by transfer ducts generally alternately located adjacent a lower portion and then an upper portion of each chamber so as to create a substantially sinusoidal flow of waste water through said discrete chambers along said portion of the flow path.

27. A system according to claim 26 wherein the baffle spacing and waste water flow rate are selected to ensure sufficient turbulence along said portion of the path to inhibit excessive deposition of sludge and substantially avoid stratification of bacteria type within the waste water travelling therethrough.

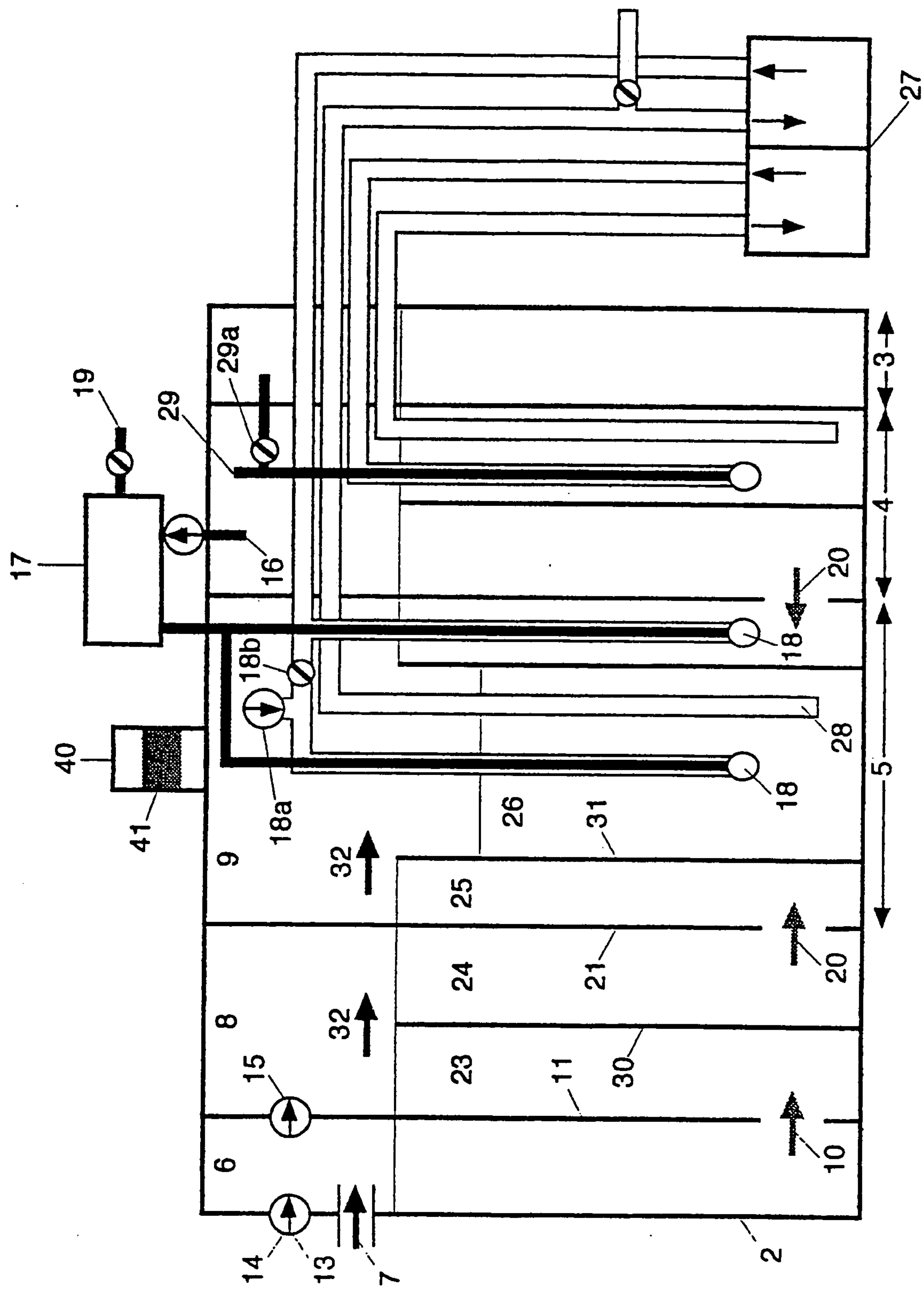

2
3
4
5
6
7
8
9
10
11
13
14
15
16
17
18
18a
18b
19
20
21
23
24
25
26
27
28
29
29a
30
31
32
40
41

Figure 1

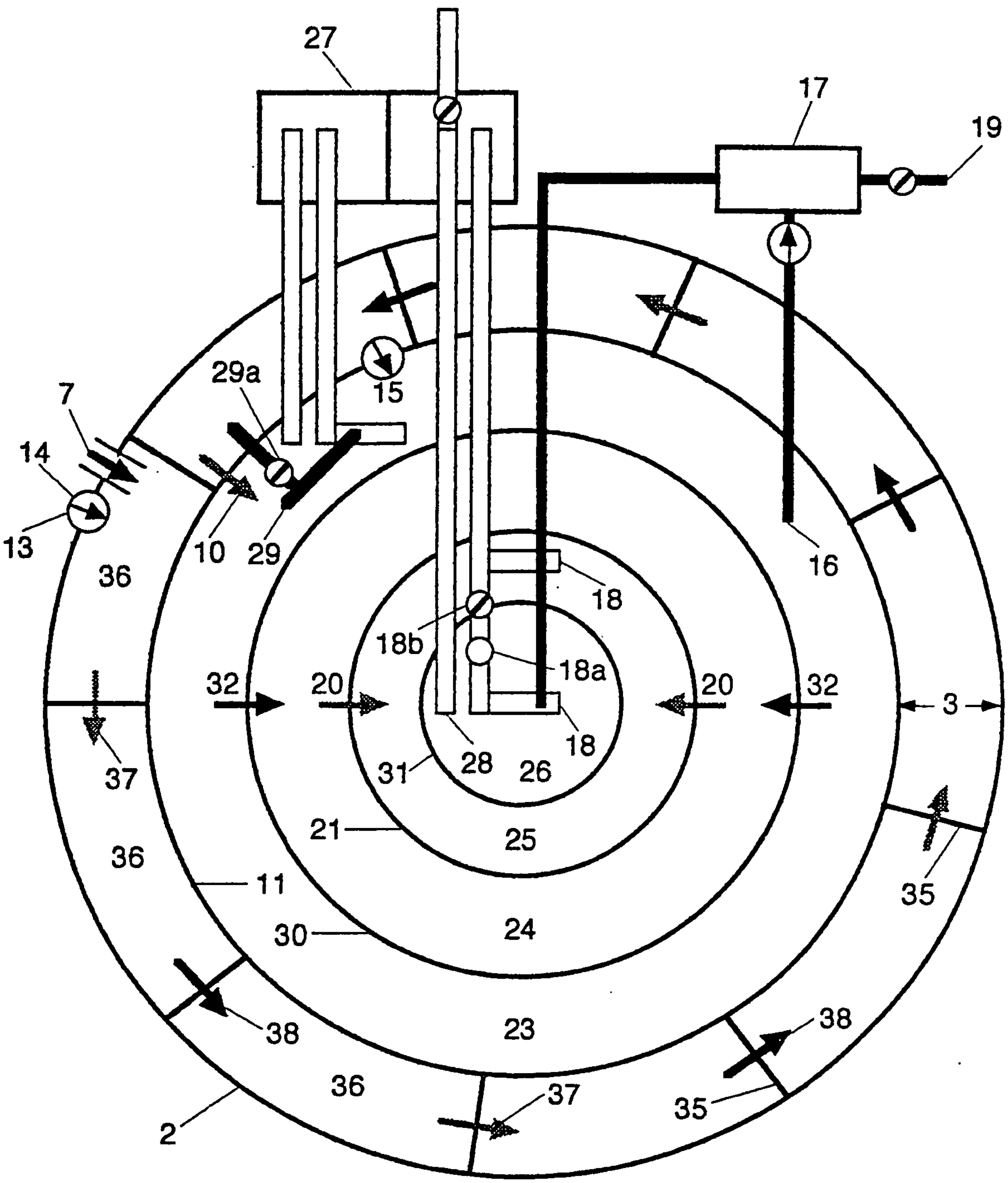

27
17
19
29a
15
7
14
13
10
29
16
36
18
18b
18a
32
20
20
32
3
37
31
28
26
18
21
25
36
11
35
30
24
38
23
38
36
37
35
2

Figure 2

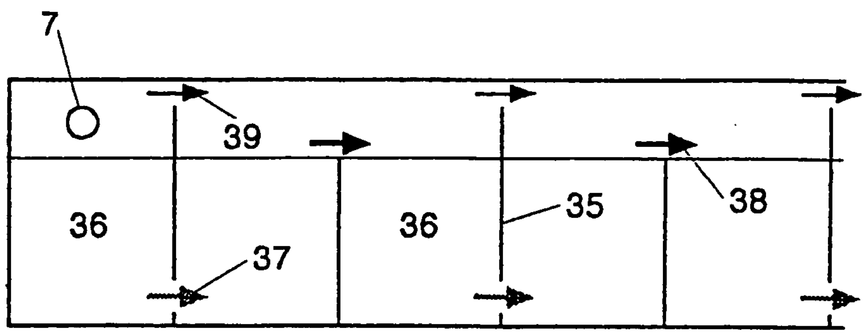


Figure 3

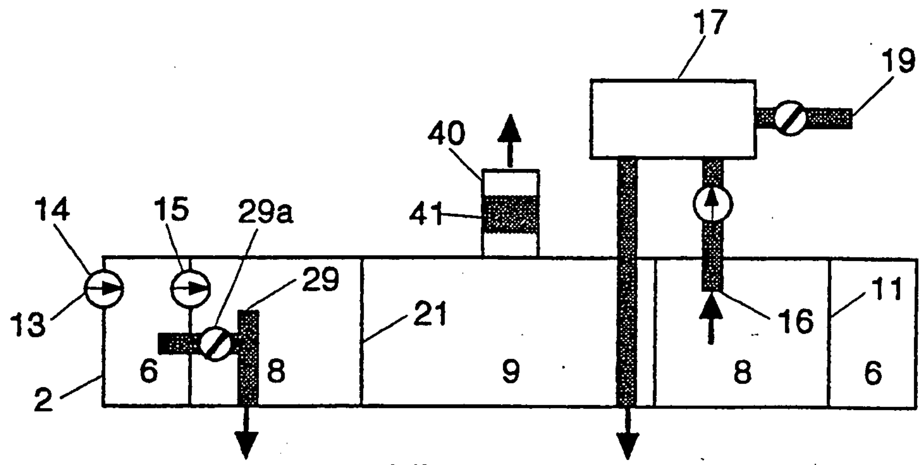


Figure 4

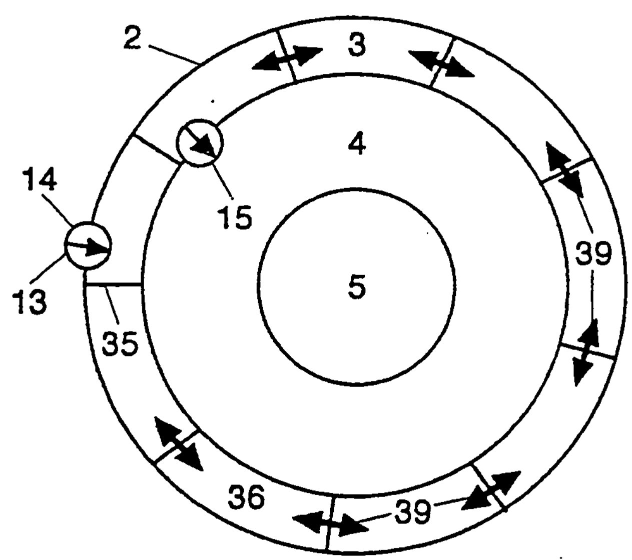


Figure 5

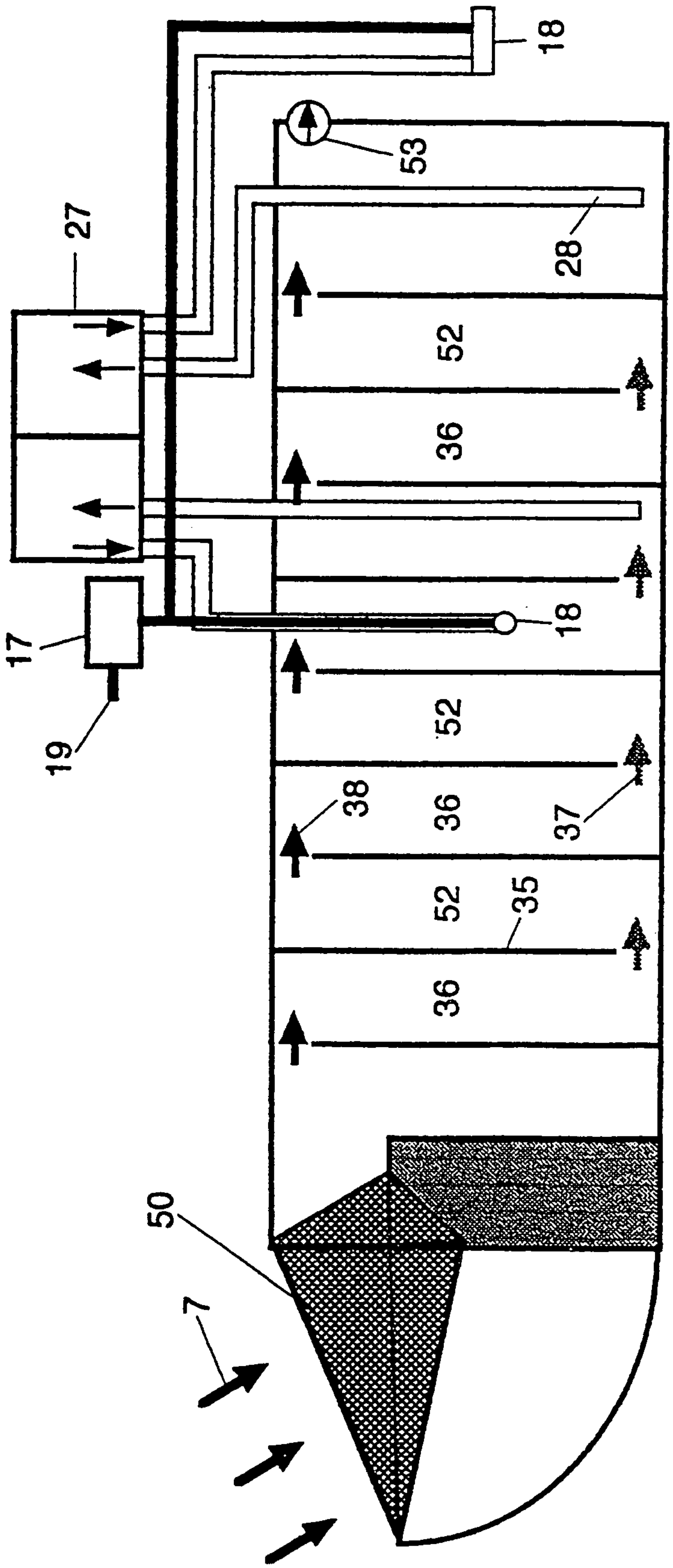


Figure 6

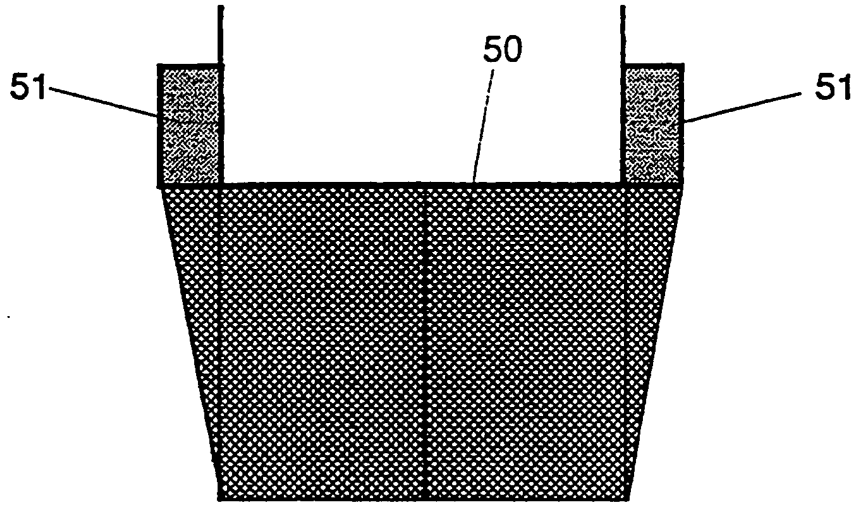


Figure 7

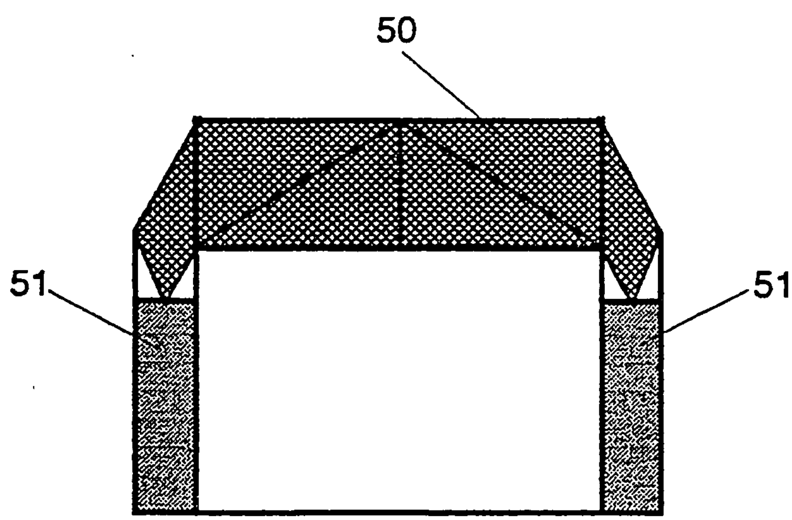


Figure 8

A. CLASSIFICATION OF SUBJECT MATTER
Int. Cl.[5] C02F 3/30, 1/78

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC[5] : C02F 3/30 IPC[3] : C02C 1/17, 5/10

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
AU : IPC as above

Electronic data base consulted during the international search (name of data base, and where practicable, search terms used)
Derwent file WPAT. Keywords used: (OZON or 03) (baffle or (chamber) and (sinusoid: or S(s) shape:)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to Claim No.
Y	US,A, 3666106 (GREEN) 30 May 1972 (30.05.72) claims, figure 1, column 1 lines 49-71	1-25
Y	FR,A, 2290223 (GROS) 4 June 1976 (04.06.76) claims 1-4	1-25
Y	Water Treatment Handbook, Volume 2, Sixth Edition, 1991 (Degremont, France) Lavoisier Publishing Inc, page 884	1-25
X	page 888	26

[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier document but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
18 January 1994 (18.01.94)	24 JAN 1994 (24.01.94)
Name and mailing address of the ISA/AU AUSTRALIAN INDUSTRIAL PROPERTY ORGANISATION PO BOX 200 WODEN ACT 2606 AUSTRALIA Facsimile No. 06 2853929	Authorized officer Ash. Te. A. TESSEMA Telephone No. (06) 2832271

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	**Citation of document, with indication, where appropriate of the relevant passages**	**Relevant to Claim No.**
P,A	AU,B, 20823/92 (639642) (DANAU et al) 22 April 1993 (22.04.93) claim 1, page 14 line 27 to page 15 line 2	1-25
X	Patent Abstracts of Japan, M77, page 7079, JP,A, 52-131653 (KUBOTA TEKKO K.K.) 4 November 1977 (04.11.77) Abstract	26-27
X	Patent Abstracts of Japan, M77, page 8089, JP,A, 52-154254 (MATSUSHITA DENKO K.K.) 21 December 1977 (21.12.77) Abstract	26-27
X	US,A, 5096577 (Ngo et al) 17 March 1992 (17.03.92) Abstract, figures 1 and 2, column 1 line 67 to column 2 line 9	26-27
X	FR,A, 2478947 (STAES, Jean-Louis) 2 October 1981 (02.10.81) figure 1, claims, page 3 lines 13-22	26-27
X	US,A, 3850801 (PEARSON, Philip J) 26 November 1974 (26.11.74) Figure 3, column 4 lines 16-61	26-27
A	Patent Abstracts of Japan, C528, page 45, JP,A, 63-100999 (TAKUMA PLANT K.K.) 6 May 1988 (06.05.88) Abstract	1-25
A	Patent Abstracts of Japan, C993, page 43, JP,A, 04-176390 (ISHIKAWAJIMA HARIMA HEAVY IND CO LTD) 24 June 1992 (24.06.92) Abstract	1-25

Box II continued

The international application does not comply with the requirements of unity of invention because it does not relate to one inventi n or a group of inventi ns so linked as to form a single general inventiv concept. In coming to this conclusion the International Searching Authority has f und that there are two inventions:

1. Claims 1-25 relate to an odour controlled waste-water system employing anaerobic, aerobic and sterilization chambers. These chambers each have head space, the second chamber additionally has air admittance means, and the third chamber additionally has ozone deliverance means. Furthermore there are means for preventing back flow of liquid and gas from the second chamber to the first chamber. There are also means for extracting deodorized gas from the third chamber head space.

2. Claims 26-27 relate to a sinusoidal waste-water flow path system. The system has a plurality of baffles arranged to produce the sinusoidal flow path of the waste-water through a plurality of discrete chambers.

Since the abovementioned groups of claims do not share either of the technical features identified, a "technical relationship" between the inventions, as defined in PCT Rule 13.2 does not exist. Accordingly, the international application does not relate to one invention or to a single inventive concept.

This Annex lists the known "A" publication level patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document Cited in Search Report		Patent Family Member					
US	5096577	AU	52878/90	AU	632017	AU	31153/93
		AU	31154/93	AU	31157/93	AU	31158/93
		BR	9007226	EP	463057	HU	902776
		IL	93699	WO	9011255	US	5180501
		US	5264127				
US	3850801	CA	1001331				

END OF ANNEX

X-AIGFROM: <gspears@AWD.com>
X-AIGTO: jstreets@PDQ.NET
From: "Spears, Gene" <gspears@AWD.com>
To: "Al Harrison (E-mail)" <virtual@hypercon.com>,
"Alan D. Rosenthal (E-mail)" <rosenthal@rosha.com>,
"Alan H. Gordon (E-mail)" <None@mercury.awd.com>,
"Albert B. Deaver Jr. (E-mail)"
<adeaver@AWD.com>,
"Albert B. Kimball (E-mail)" <akimball@bracepatt.com>,
"Alberto Q. Amatong Jr. (E-mail)" <aamatong@fulbright.com>,
"Alton W. Payne (E-mail)" <alpayne@netropolis.net>,
"Andrew B. Griffis (E-mail)" <andrew.b.griffis@exxon.com>,
"Andrew G. Dinovo (E-mail)" <adinovo@velaw.com>,
"Anita E. Kadala (E-mail)" <ack@tghiplaw.com>,
"Anthony Matheny (E-mail)"
<amatheny@tgiplaw.com>,
"Ari O. Pramudji (E-mail)" <apramudji@AWD.com>,
"B. Todd Patterson (E-mail)" <tpatterson@paiplaw.com>,
"Barry E. Engel (E-mail)" <bengel@velaw.com>,
"Ben D. Tobor (E-mail)"
<bdt@tgiplan.com>,
"Benjamin J. Bai (E-mail)" <bbai@jenkens.com>,
"Bernarr Pravel (E-mail)" <bpravel@akingump.com>,
"Beverlee G. Steinberg (E-mail)" <bgsteinberg@shellus.com>,
"Bill Durkee (E-mail)" <bdurkee@AWD.com>,
"Brian E. Simmons (E-mail)"
<bsimmons@AWD.com>,
"Brian K. Buss (E-mail)" <bbuss@vinsonelkins.com>,
"Brian K. Hrna (E-mail)" <bkhrna@msn.com>,
"Brian L. Jackson (E-mail)"
<bjackson@AWD.com>,
"Brigitte L. Jeffery (E-mail)"
<jeffery@sugar-land.spc.slb.com>,
"Bruce K. Jamison (E-mail)"
<bruce@oldsmokey.com>,
"Bruce W. Slayden II (E-mail)"
<bslayden@frohwitter.com>,
"C. Alan McClure (E-mail)" <a-mcclure@ti.com>,
"C. Dale Quisenberry (E-mail)" <cdq@tgiplaw.com>,
"C. Dean Domingue (E-mail)" <ddomingue@prodigy.net>,
"C. Gerard Harrison (E-mail)" <gharrison@AWD.com>,
"C. James Bushman (E-mail)" <iplawcjb@echonet.com>,
"C. Steven McDaniel (E-mail)" <smcdaniel@hooucrt.com>,
"Carey J. Hetherington (E-mail)" <carey_hetherington@bakerbotts.com>,
"Carl A. Rowold (E-mail)" <carl.rowold@bakerhughes.com>,
"Carlos A. Torres (E-mail)" <iplawcat@echonet.com>,
"Carol G. Mintz (E-mail)" <cmintz@houcrt.com>,
"Carrie A. Boone (E-mail)"
<cboone@akingump.com>,
"Carter J. White (E-mail)" <cwhite@AWD.com>,
"Chandran D. Kumar (E-mail)" <ckumar@houcrt.com>,
"Charlene H. Tsang (E-mail)" <ctsang@bmoh.com>,
"Charles Alexander Thomasian (E-mail)" <cthomasian@houcrt.com>,
"Charles B. Walker (E-mail)" <cbwalker@fulbright.com>,
"Charles J. Rogers (E-mail)" <ipattorney@aol.com>,
"Charles M. Cox (E-mail)" <ccox@akingump.com>,
"Christopher G. Hayden (E-mail)" <chayden@AWD.com>,
"Christopher R. Benson (E-mail)" <cbenson@AWD.com>,
"Clarence E. Eriksen (E-mail)" <ceriksen@AWD.com>,
"Claude E. Cooke Jr. (E-mail)" <ccooke@bakerbotts.com>,
"Claude Mundy (E-mail)" <cmundy@duke-energy.com>,
"Coe F. Miles (E-mail)"
<miles@tphm.com>,
"Colin E. Errington (E-mail)" <cee@tgiplaw.com>,
"Connie Flores Jones (E-mail)" <cflores@AWD.com>,
"Constance Gall Rhebergen (E-mail)" <crhebergen@patentlawyers.com>,
"Craig M. Lundell (E-mail)" <clundell@AWD.com>,
"Craig W. Walford (E-mail)" <craig.walford@mwk.com>,
"Cynthia G. Seal (E-mail)" <cseal@wt.net>,
"D. C. Toedt III (E-mail)"
<dctoedt@AWD.com>,
"Dan Hu (E-mail)" <hu@tphm.com>,

ELECTROLYSIS CELL FOR GENERATING OZONE AND/OR OXYGEN

FIELD OF INVENTION

The invention relates to an electrolysis cell for generating ozone and/or oxygen from superpure water with a solid electrolyte membrane disposed in a multipartite housing, said membrane being in direct contact with electrodes designed as porous structures, with the membrane separating the cathode space from the anode space, and with a surface pressure acting on the membrane and on both electrodes, said pressure being generated by a pressure device acting on at least one of the electrodes.

BACKGROUND OF THE INVENTION

Electrolysis cells for generating ozone based on ion-exchange membranes in direct contact with electrodes said electrodes consisting of a porous material or coated therewith, are characterized by the ability to operate at high current densities and hence high reaction rates. The ion-exchange membrane acting as the solid electrolyte membrane simultaneously acts as a separator for the anode and cathode spaces and the electrolytes. Cells of this design have been known for some time, with hydrated, perfluorinated cation-exchange membranes being used, said membranes exhibiting an electrochemical stability with respect to the reducing or oxidizing effect of the electrodes (uncoated or coated Nafion 117 membrane, see Stucki "Reaktion und Prozesstechnik der Membrel-WasserElektrolyse," Dechema Monografien Verlag Chemie 94 (1983) 211).

Mention should also be made of the *Handbook of Water Purification*, second edition, Walter Lorch/Ellis Horwood Ltd. 1987, Pages 513 to 529, as well as the special issue of Suisse Chem 8 (1986) 10*a*, pages 31 to 33, "Funktionsweise und Einsatzgebiete eines elektrochemischen Ozonerzeugers" by Bauman and Stucki (in English: "In Situ Production of Ozone in Water Using a Membrel Electrolyzer" of Mrs. S. Stucki, G. Theis, R. Kotz, H. Devantay and H. J. Christen, published in Journal of the Electrochemical Society, Volume 132, No. 2, February, 1985). Such cells can be operated basically in media with a low electrical conductance, for example chemically pure water. The electrochemical reactions on the electrodes during operation in superpure water result in the formation of hydrogen and oxygen; when special anode materials are used, a mixture of oxygen and ozone can be produced instead of pure oxygen.

Electrolysis cells of this type require the porous and planar anode and cathode to be pressed against the surfaces of the solid electrolyte membrane. The pressure applied to the membrane is therefore an important parameter for optimum operation of the cell. Thus the cell voltage and current yield depend on the pressure applied. The pressure applied must be as homogenous as possible over the entire surface to achieve a uniform current distribution over the entire electrode surface. This is particularly problematical in electrodes with large surface areas.

It is known that electrolysis cells of this kind can be designed such that the pressure applied is transmitted to the cell housing by a circle of screws or tie rods. The pressure exerted by the screws is distributed to the sealing surfaces of the housing parts of the electrolysis cell to be connected together and over the surface pressure of the electrodes with respect to the solid electrolyte membrane.

In such designs, the electrodes must be manufactured with very low tolerances so that sealing and pressure functi ns can be fulfilled simultaneously. In addition, when the screws

are tightened, there is a risk of tilting that results in inhomogeneous distribution of the applied pressure and thus to inhomogeneous current distribution.

SUMMARY OF THE INVENTION

The goal of the invention is to provide a simple economical design for an electrolysis cell of the type according to the species for producing ozone and/or oxygen, in which it is possible with simple means to achieve a uniform pressure for application of the electrodes against the solid electrolyte membrane and to permit a simple assembly of the electrolysis cell.

According to the invention this goal is achieved in an electrolysis cell according to the species by having the pressure device include a pressure screw equipped with a convex head, said screw being arranged such that the convex head is placed centrally directly on the cathode or anode and forms an indentation in the cathode surface or anode surface under the influence of the applied pressure. Since the cathode and anode are made of a porous material, for example a ductile sintered material, for making ozone or oxygen, the convex head of the pressure screw can be forced into the surface of the cathode or anode by exerting a pressure, resulting in the formation of an indentation, and as a result of this indentation a very uniform pressure and very good contact with the cathode and anode can be produced, and a very uniform pressure can be exerted through the cathode or anode on the membrane. In addition, angle errors in the pressure screw during application of pressure are compensated as well. A precondition for optimum exertion of a uniform pressure by the cathode and/or anode on the membrane is the central guidance of the pressure screw. With the aid of the pressure screw according to the invention, a spherical central indentation is created, namely a dent in the form of a concave spherical segment that permits very good contact and hence very good pressure transmission with uniform distribution over a larger area. In particular, the pressure transmitted by the pressure device, namely the pressure screw, is applied directly to the cathode and anode. Advantageous embodiments of the electrolysis cell according to the invention are included in the characterizing features of the subclaims. For economical manufacture of the electrolysis cell, it is proposed to assemble the housing of a central cell body with covers on both the anode side and the cathode side. The covers are preferably made of a corrosionproof nonconducting material, for example a suitable ozone-resistant plastic, especially a polymer containing fluorine, such as polyvinylidene fluoride (PVDF), perfluoroalcoxy (PFA), polytetrafluoroethylene copolymer (PTVE copolymer), polyfluoroethylene propylene (PEP), or ethylene-tetrafluoroethylene copolymer (ETFE). The housing body can also be made of one of the above-mentioned ozone-resistant plastics. All housing parts made of plastic can be produced by injecting molding for example.

It is also possible to make the central housing part, i.e. the cell body, of metal, especially corrosionproof and ozone-resistant stainless steel. When the cell body is made of stainless steel, the anode carrier is insulated from the cell body by insulating inserts, based for example on fluorinated polymers, like those used for the covers, or tight ceramic materials. The metal cell body is then at cathode potential (minus pole).

For simple assembly, it is also proposed that the cell body be formed symmetrically with respect to its central axis, having a through bore with shoulders expanding in stages starting at the anode side and progressing to the cathode